# ECS15:
# Introduction to Computers
# Lecture 2

- Exponential growth in computation and information
- The Term paper

## Goals of this course

- Understand how a computer works:
  1) input (a string of letters or numbers, a picture, a waveform/sound, etc.);
  2) program (algorithm: transforms the data)
  3) output (a human-useful format: string, picture, etc).
- Become computationally aware and literate in software, programming basics and internet workings.
- Learn the process of writing a scientifically sound and rigorous paper.

## Why?

- ***Basic knowledge of computers***
  - Order a computer online
  - Buy a digital camera
  - Configure your wireless router
- ***Basic understanding of software and tools***
  - Word processing, etc.
- ***Security and privacy***
- ***Writing programs to solve your own problems***
- ***Understanding how to query and find information***

## CS in the News, Dec 12, 2014


For more political cartoons, visit: www.theweek.com/cartoons.

## CS in the News, Dec 12, 2014

**BUSINESS** 35

# The news at a glance

Reprinted from *The Week.*

## Entertainment: Sony suffers massive cyberattack

Sony Pictures suffered one of the biggest corporate cyberattacks ever this week, said **Tom Gara** and **Charlie Warzel** in *BuzzFeed .com*. More than 40 GB of internal documents were leaked online, including unreleased film and TV scripts, salary information for more than a dozen top executives, and thousands of employees' Social Security numbers, background checks, medical histories, and performance reviews. Five of the studio's films were pirated and posted online, including the upcoming *Annie* and the World War II movie *Fury*, starring Brad Pitt. Millions of copies of the films were being illegally downloaded this week, costing Sony millions in box-office sales.

*Actors Franco and Rogen*

Suspicion has fallen on North Korean hackers, said **Brooks Barnes** and **Nicole Perlroth** in *The New York Times*. Sony is just weeks away from releasing *The Interview*, a comedy in which actors Seth Rogen and James Franco play American journalists hired by the CIA to assassinate North Korean leader Kim Jong Un. A spokesman for North Korea's foreign ministry has called the film "the most undisguised terrorism and a war action" and promised "a strong and merciless counter-measure." Sony is also investigating whether an aggrieved ex-employee might be behind the breach. Hundreds of Sony employees have been let go this year in cost-cutting measures.

Was it North Korea or a disgruntled employee? (Search and find out)

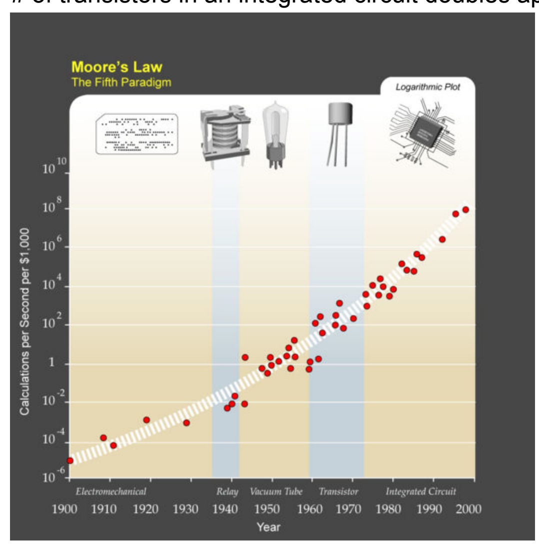
## Computation and Information is currently transforming all disciplines:

- Origins of WWW: sharing high energy physics data.
- Social Sciences (immunology, economics, sociology) – online social networks (Facebook, Twitter, LinkedIn.)
- Biological sciences: DATABASES
  - Human and other genomes (Terrabytes every month)
  - Microarray data of gene coexpression
  - Protein and gene interaction networks
  - Protein folding libraries
- Archeology: genetic evidence to link migration.
- Cosmology: terrabytes of data
- Geology/seismology: massive instrumentation (sensor networks)
- Entertainment -> user generated like youtube.com

## Fact: You will need to understand computation and how to use it

- Goal: Understand **ICT** (**I**nformation and **C**ommunication **T**echnologies).
- Computer literacy required at most jobs. (Ability to write clearly and correctly: reports, emails,)
- Social networks: privacy, identity theft, finding contacts and opportunities.
- Data privacy (increasingly important)
- Cloud storage of content (e.g., iCloud, dropbox, gmail, …). (Your content lives in a remote server not on your local machine necessarily.)

**Moore's Law**: The **exponential** growth in computational power per dollar. The # of transistors in an integrated circuit doubles approximately every two years.




(http://) en.wikipedia.org/wiki/Accelerating_change

Exponential growth: $y = e^x$

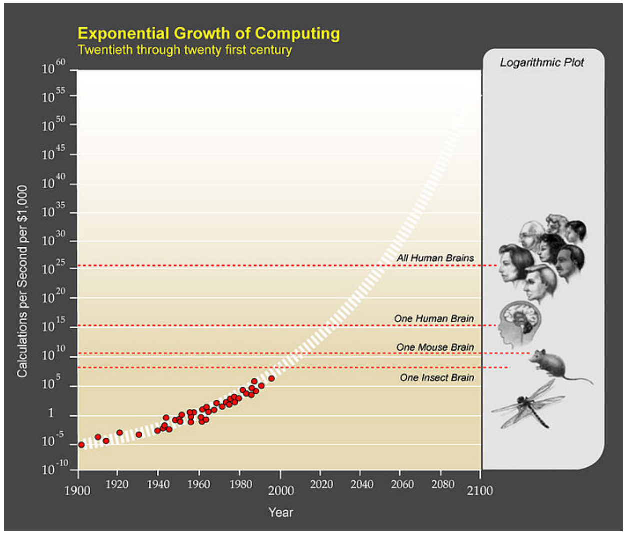
Note:
X-axis is *linear*
Y-axis is *logarithmic*

Log indicates the **order of magnitude of a number.** In base 10:

$\log(10) = 1$
$\log(100) = 2$
$\log(1000) = 3$

(What base do computers count in?)

- By 2020, speed of one human brain
- By 2050, speed of all human brains combined! (The “singularity”)



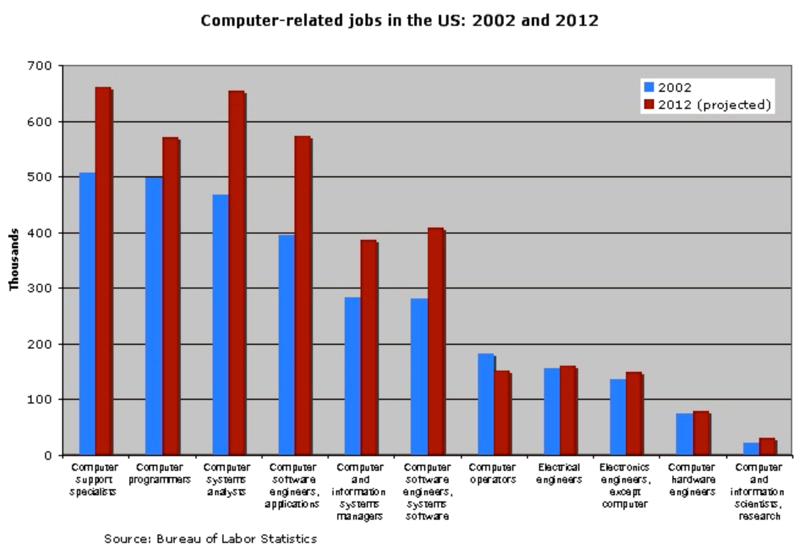

Moore’s Law (Gordon Moore, founder of Intel)

*(http://en.wikipedia.org/wiki/Accelerating_change)*

## The growth of computation and information

- In your lifetime, the number of operations per second will exceed the capacity of all human brains combined!

- In your lifetime it is possible that the amount of data generated each day will exceed the amount of data ever written previously. (We will soon reach the point where the content on the WWW exceeds all the content ever written.)




## How to get a good grade?

- ***Computers are rational***
  - Understand, not memorize.
- ***Active classroom participation;*** e.g. ask questions, in class exercises. This will help if you are boarder line in grades.
- ***Do your own assignments***
  - You will understand what you do!
- ***Make sure you check the web site + notes + textbooks***
- ***Midterm course review***
- ***Final review***

## What we will study

- ***Computers (3-4 weeks)***
  - Hardware: motherboard, processor, memory, I/O devices, etc.
  - Software and application:
  - Graphics: image, video, 2D, 3D, game,
  - History and ethics
- ***The Internet (2-3 weeks)***
  - Layered architecture
  - Applications: web, email, p2p, etc.
  - The path of your email/webpage.
  - LAN: local area network, wireless local area network.
  - Security
- ***Python Programming (3-4 weeks)***
  - Getting started
  - Basic concepts: type, variable, I/O
  - Loops: while, for,
  - Conditionals: if

## Why Programming

- What is a program?
- You can handle little problems yourself
- You know when you hire someone how big a job it is (like going to a mechanic)
- You have some idea of what is possible.
- A good programmer has more job options (you'll need more than this one class, though)

## Why Python?

- Useful and popular
  - Great for interfacing one program to another
  - Widely used in industry –Google, ILM, NASA….
- Free
- Easy to get started with
  - Lots of "libraries" (add-ons) that do things like sound editing, computational biology, Web database access…..

## It teaches you to think!

- The computer is your genie in a bottle
  - It can be your best help
  - It can be really frustrating
- It does exactly what you tell it to
- Your job is to figure out what/how to tell it.
- Learning the language is easy, …
- Some people really like it!

# Other options

- ECS 10: Programming in Python
  - You will get full credit (after taking ECS 15)
  - GE class
- ECS 30: More intensive class for those with some programming experience (basic, c, java), learn C++, required for ECS majors.

# Term paper

- *20% of the total grade*
- *~2500 words (around 10 pages)*
- *A research paper on a topic related to computers that interest you*
- *An opportunity to learn how computers are used in an area you are interested in.*
- *Start early!* **(Dates below may change, stay posted.)**
- ***Prospectus due Friday, January 23***
- ***Progress report Due Friday, February 6***
- ***Draft due Friday, February 20***
- ***The paper itself is due Friday, Mar 13***
- ***All due at 6pm, submitted via Smartsite.***

# Possible Topics

- ***Computers in education***
  - for teaching reading
  - for teaching music
- ***Computers in biology***
  - bioinformatics
  - computational biology
- ***Computers in art, architecture, and design***
  - computer-generated and computer-supported art
  - computer-aided design
- ***Digital libraries***
  - legal issues (e.g., intellectual property)
  - technologies
- ***Music on the Internet***
  - -- New revenue models
  - -- Digital rights management
- ***Internet on entertainment***
  - P2P file sharing
  - Video-on-demand
  - E-books
- ***Social networking websites and their impacts***
  - -- Copyright and Digital Rights Management
- ***Online advertising***
  - Google, adwords, auctions, consumer behavior
- ***Security and privacy***
- ***computer and/or Internet addiction***
- ***failures due to computers***
  - -- Stock market crash due to automated trading
- ***famous computer viruses and "worms"***
- ***Digital divide***

# Judging the feasibility of a topic

- Is it a topic you are excited about?
- Is there enough existing research in this area to conduct a scholarly study?
  - Finding existing literature --- e.g., scholar.google.com, webofknowledge.com, pubmed.com (Note cited reference search—see the follow-on work)
  - Let's do an in-class example – **someone please suggest topics**
- What is my *hypothesis?* (What kind of interesting results can I expect to find?)
- How can I validate or invalidate my hypothesis?
- What are the *implications* of my conclusions?

## Computer Science

- Theory of computation
- Software engineering
- Computer graphics
- Computer security and cryptography
- Computer networks
- Artificial intelligence
- Human-computer interface
- Bioinformatics
- Systems and architecture

## Computers and You

- ***The computer will implement whatever you tell it to***
  - It can be your best friend
  - It may mean a lot of frustration
- ***It does exactly what you tell it to***
- ***Your job is to figure out what/how to tell it!***
- ***Learning the language is easy…***
- ***First Digital Data***
- ***Second Programming: instructions (algorithms) for data transformation***
- ***Third Digital Logic: from algorithm to transistors***

## Growth Mindset

- Test your mindset: Do you agree that intelligence is something about a person that he/she can't change very much?
  - Strongly agree to strongly disagree
- Fixed mindset vs. growth mindset
- Can one learn to be good at computers?
  - Yes, absolutely.
  - And yes, absolutely worth your time and effort
- Google "growth mindset" for more information.

- Focus and Concentration are skills.
- Practice "distraction free hour"!
  - A study by Microsoft shows it takes 15 mins to return to deep concentration once distracted by text/email.

## Topic 1: Digital Data

- Binary and Hexadecimal numbers
- ASCII code and UNICODE
- Sampling and Quantitizing
  - *Example: sound*

# Basic Concepts

- Binary and Hexadecimal numbers
- ASCII code and UNICODE
- Sampling and Quantitizing
  - *Example: sound*

# Number representation

*We are used to counting in base 10:*

| | 1000 | 100 | 10 | 1 |
|---|---|---|---|---|
| | $10^3$ | $10^2$ | $10^1$ | $10^0$ |
| ….. | thousands | hundreds | tens | units |

*Example:*

| 1 | 7 | 3 | 2 | ← *digits* |
|---|---|---|---|---|
| 1000 | 100 | 10 | 1 | |

1x1000+7x100+3x10+2x1 = 1732

# Number representation

*Computers use a different system: base 2:*

| 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |

*Example:*

| 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | ← *bits* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 | |

1x1024+1x512+0x256+1x128+1x64+0x32+ 0x16+ 0x8 + 1x4 + 0x2 + 0x1 = 1732

# Number representation

| Base 10 | Base 2 |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 2 | 10 |
| 3 | 11 |
| 4 | 100 |
| 5 | 101 |
| 6 | 110 |
| … | … |
| 253 | 11111101 |
| 254 | 11111110 |
| 255 | 11111111 |
| … | … |

# Conversion

*From base 2 to base 10:*

| 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

1x1024+1x512+1x256+0x128+1x64+0x32+ 1x16+ 0x8 + 1x4 + 0x2 + 0x1 = 1876

*From base 10 to base 2:*

1877 %2 = 938 Remainder 1
938 %2 = 469 Remainder 0
469 %2 = 234 Remainder 1
234 %2 = 117 Remainder 0
117 %2 = 58 Remainder 1
58 %2 = 29 Remainder 0
29 %2 = 14 Remainder 1
14 %2 = 7 Remainder 0
7 %2 = 3 Remainder 1
3 %2 = 1 Remainder 1
1 %2 = 0 Remainder 1

1877 (base10) = 11101010101 (base 2)

# Facts about Binary Numbers

-Each “digit” of a binary number (each 0 or 1) is called a bit

-1 byte = 8 bits
-1 KB = 1 kilobyte = $2^{10}$ bytes = 1024 bytes (≈1 thousand bytes)
-1 MB = 1 Megabyte = $2^{20}$ bytes = 1,048,580 bytes (≈ 1 million bytes)
-1 GB = 1 Gigabyte = $2^{30}$ bytes = 1,073,741,824 bytes (≈1 billion bytes)
-1 TB = 1 Tetabyte = $2^{40}$ bytes = 1,099,511,627,776 bytes (≈ 1 trillion bytes)

-A byte can represent numbers up to 255: 11111111 (base 2) = 255 (base 10)
-The maximum number represented by a binary number of size N is $2^N - 1$